

Remarks

Claims 1-15 were originally in the case. As a result of the restriction requirement, the Examiner has withdrawn claims 10-15 from consideration.

Election/Restriction

In paragraphs 1-6 of the Office Action, restriction under 35 U.S.C. § 121 to either Invention I comprising claims 1-9 or Invention II comprising claims 10-15 is required. Invention I is directed to a method of cleaning semiconductor wafers while Invention II is directed to an apparatus for pre-epitaxial cleaning. The Examiner notes that a telephone call was made to Mr. Fein on February 3, 2004 to request an oral election for the restriction requirement but did not result in an election being made. However, during the February 3, 2004 telephone conversation, Mr. Fein did elect Invention I, comprising claims 1-9, with traverse. Nonetheless, and for the record, Applicants formally elect *with traverse* Invention I, comprising claims 1-9, for examination.

Drawings

Regarding paragraph 7 of the Office Action, proposed figure 1 is enclosed herewith and is intended to replace original figure 1. Proposed figure 1 differs from original figure 1 only in that the legend has been changed from “Comparative” to “Prior Art.” This change was made at the suggestion of the Examiner set forth in paragraph 7 of the Office Action. No new matter is added.

It is believed that proposed figure 1 obviates the objection set forth in paragraph 7 of the Office Action and, thus, it is requested that the objection to the drawings be withdrawn.

Specification

Regarding paragraph 8 of the Office Action, the specification was objected to for it was not clear and there was no guidance what the recited terms, such as the dissolved oxygen, the

total organic carbon, and the total dissolved silica were related to. The specification has been amended to clarify that these terms are parts per billion in water. No new matter is added. While the relation of these terms to water was not recited, those skilled in the art would have clearly understood this to be the case. In fact, the Patruno reference cited in the present application also mentions Total Organic Content and Dissolved Oxygen in parts per billion with the understanding that it is water. See Patruno, pg. 249.

Regarding paragraph 9 of the Office Action, the specification was objected to because the paragraph that bridged pages 4-5 duplicated the recitation of the description of drawings 6-10. The paragraph that bridged pages 4-5 is amended to remove the duplication. No new matter is added.

It is believed that the amendments to the specification made herewith overcome the objections set forth in paragraphs 8 and 9 of the Office Action and, thus, should be withdrawn.

Claim Objections

In paragraph 10 of the Office Action, claim 1 was objected to because line 4 recited “etching silicon wafers with HF” while etching silicon wafers with HF solution was indicated and because line 6 recited “dilute HF” while dilute HF solution is indicated. Claim 1 is amended to recite that the HF is a HF solution while the dilute HF is a dilute HF solution. In order to maintain consistency, claim 1 is also amended to recite that the dilute SC1 is a dilute SC1 solution. These amendments are made solely to overcome the objection in paragraph 10 of the Office Action and for consistency. These amendments are not made to distinguish prior art. No new matter is added. Support can be found in original claims 3, 4, and 5.

It is believed that the aforementioned amendments to claim 1 overcome the objections set forth in paragraph 10 of the Office Action, thus, it is requested that the objection be withdrawn.

Claim Rejections – 35 U.S.C. § 112

In paragraph 12 of the Office Action, claims 7, 8, and 9 were rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. Specifically, claims 7, 8, and 9 were rejected because the limitations, such as the dissolved oxygen, the total organic carbon, and the total dissolved silica fail to describe what these limitations are related to. Claims 7, 8, and 9 are amended to specify that the dissolved oxygen, the total organic carbon, and the total dissolved silica are related to the amount of these materials in water. No new matter is added. While the relation of these terms to water was not recited, those skilled in the art would have clearly understood this to be the case. In fact, the Patruno reference cited in the present application also mentions Total Organic Content and Dissolved Oxygen in parts per billion with the understanding that it is water. See Patruno, pg. 249.

In paragraph 13 of the Office Action, claims 7, 8, and 9 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite because the terms “the dissolved oxygen,” “the total organic compound,” and “the total dissolved silica” lack proper antecedent basis. Claims 7, 8, and 9 are amended to remove the word “the” before each of these terms. No new matter is added.

The amendments to claims 7, 8, and 9 are made for the sole reason to overcome the 35 U.S.C. § 112 rejections set forth in paragraphs 12 and 13 of the Office Action. The amendments are in no way made to distinguish prior art. It is believed that the amendments to claim 7, 8 and 9 overcome all of the rejections set forth in paragraphs 12 and 13 of the Office Action and, thus, the rejections should be withdrawn.

Claim Rejections – 35 U.S.C. § 103

In paragraph 17 of the Office Action, claims 1-3 and 5-9 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application Publication 2002/0102852 (“Verhaverbeke”) in view of the *IN-SITU HF-LAST FOR PRE-EPITAXY CLEANING*, UCPSS, pp.247-250 (1994) (“Patruno”).

Regarding the rejection of claim 1, Verhaverbeke was cited as teaching a method of cleaning silicon semiconductor wafers including the steps of: (A) etching the semiconductor wafers with 2% solution of HF to strip an oxide surface; (B) rinsing the etched wafers with ozonated DI water; (C) treating the rinsed wafers with a solution that reads on Dilute SC1, namely a solution comprising ammonium hydroxide, hydrogen peroxide, and water; (D) rinsing the wafers with DI water; and (E) drying the wafers with nitrogen and IPA, wherein all of the recited steps are performed in the same processing chamber. The Office Action acknowledges that Verhaverbeke does not teach the two additional steps recited in claim 1 of treating the wafers with dilute HF solution after the initial rinse and rinsing the wafers after the treatment with dilute HF. Patruno is cited as teaching these missing steps and is combined with Verhaverbeke to reject claim 1 under 35 U.S.C. § 103(a).

The rejection of claim 1 over Verhaverbeke in view of Patruno is improper for a number of reasons.

First, Verhaverbeke is not properly combinable with Patruno to show the addition of the two missing process steps. Verhaverbeke is directed to the discovery of a single wafer cleaning process that can be economically performed in comparison to traditional SC1/SC2 wafer batch cleaning processes. See Verhaverbeke, paragraph 0008 and FIG. 6. Verhaverbeke specifically states that “in order to make a single wafer cleaning process economical, the processing time per wafer should be on the order of two minutes.” See Verhaverbeke, paragraph 0008. Being that the entire focus of Verhaverbeke is to reduce the process time and efficiency of the cleaning step, it is counter intuitive that one skilled in the art would be motivated to perform the two additional steps recited in Patruno. In fact, Verhaverbeke specifically teaches away from increasing the number of process steps because the entire focus of Verhaverbeke is to reduce process time by using a modified SC1 solution *to eliminate/combine traditional cleaning steps*. See e.g., Verhaverbeke, paragraph 0045. Moreover, adding the missing steps of treating the wafers with dilute HF solution and rinsing the wafers a second time to the Verhaverbeke process could increase the process time per wafer above the two minute economical limit. Thus, one skilled in the art would not be motivated to perform the additional process steps cited in Patruno with the

cleaning process of Verhaverbeke. To hold otherwise is to combine the teachings of Verhaverbeke and Patruno using impermissible hindsight to recreate the Applicants' invention.

Second, Verhaverbeke does not teach the step of treating the rinsed wafers with dilute SC1 solution, as is required by claim 1. Instead, Verhaverbeke specifically teaches using a special cleaning solution comprising of ammonium hydroxide, hydrogen peroxide, and water, a chelating agent, and a surfactant. See Verhaverbeke, paragraph 0036. Moreover, a mixture of ammonium hydroxide, hydrogen peroxide, and water are present in dilution ratios of "between 5/1/1 and 1000/1/1, respectively." See Verhaverbeke, paragraph 0036. According to these ratios, a large portion of the cleaning solution is ammonium hydroxide, not water, as is the case in the present invention. Therefore, the cleaning solution used in Verhaverbeke is not a diluted SC1 solution, as required by claim 1.

Therefore, because Verhaverbeke and Patruno are not properly combinable, the rejection of claims 1-3 and 5-9 under 35 U.S.C. § 103(a) are improper and should be withdrawn.

Regarding the merits of the rejection of claim 2, claim 2 recites "wherein the dried wafers are subsequently treated in an epitaxial reactor and baked at a temperature of 700 °F or less." In rejecting claim 2, the Office Action states that the combined teachings of Verhaverbeke and Patruno provides for further thermal processing at typical temperature of 400 °C. However, this rejection is improper because the references do not alone, or in combination, teach or suggest the step of subsequently treating the wafers in an epitaxial reactor and baked at a temperature of 700 °F or less."

Turning first to Patruno, Patruno teaches treating dried wafers in an epitaxial reactor at a pre-clean temperature of *1100 degrees* and a deposition temperature of *1050 degrees*. See Patruno, pg. 248. Thus, Patruno, does not teach or suggest subsequently treating the dried wafers in an epitaxial reactor and baked at a temperature of 700 °F or less, as is required by claim 2.

Turning now to Verhaverbeke, Verhaverbeke teaches, after the wafer is dried, removing the wafer from the chamber and thermally processing in a single wafer furnace. While it is true

that Verhaverbeke states that the thermal processes are typically performed at temperatures exceeding 400°C, Verhaverbeke specifically enumerates that the thermal process may be an anneal, a chemical vapor deposition (CVD), or an oxidation. See Verhaverbeke, paragraphs 0064 and 0068. *There is absolutely no suggestion in Verhaverbeke that the thermal process can be epitaxial layer growth.* Therefore, Verhaverbeke does not teach or suggest subsequently treating the dried wafers in an epitaxial reactor and baked at a temperature of 700 °F or less, as is required by claim 2.

Thus, neither Patruno or Verhaverbeke teach the recited limitation of “wherein the dried wafers are subsequently treated in an epitaxial reactor and baked at a temperature of 700° F or below,” as is required by claim 2. Therefore, the rejection of claim 2 under 35 U.S.C. § 103(a) over Verhaverbeke in view of Patruno is improper and must be withdrawn.

Regarding the merits of the rejection of claim 5, the Examiner failed to disclose where either of the Verhaverbeke or Patruno references teach wherein “the dilute SC1 solution is a solution of 0.1 to 0.5% by weight ammonium hydroxide and about 0.1 to 1 % by weight hydrogen peroxide in water,” as is required by claim 5. Because the burden is on the Examiner to present a *prima facie* case of obviousness, Applicants request that the rejection of claim 5 be deemed improper and withdrawn accordingly.

In paragraph 18, claim 4 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application Publication 2002/0102852 (“Verhaverbeke”) in view of the *IN-SITU HF-LAST FOR PRE-EPITAXY CLEANING*, UCPSS, pp.247-250 (1994) (“Patruno”) and in further view of U.S. Patent 6,495,099 (‘099 Patent). Claim 4 depends on claim 1. Because claim 1 is argued as being allowable over the combination of Verhaverbeke and Patruno, and because the ‘099 patent does not supply the deficiencies noted above, claim 4 is also allowable over the current rejection. Therefore, the rejection should be withdrawn.

It is believed that all grounds of rejection have been traversed or obviated, and that none of the references, either alone or in combination, teach or suggest the claimed invention. It is requested that all of the rejections be withdrawn and that the claims be allowed.

DOCKET NO. 108430.030B

PATENT

Serial No. 10/091,011

Response to Office Action Dated February 12, 2004

May 5, 2004

Respectfully submitted,

COZEN O'CONNOR

BY: Brian L. Belles
Brian L. Belles (Reg. No. 51,322)
Cozen O'Connor
1900 Market Street
Philadelphia, PA 19103
(215) 665-7244